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SPECIFICATION

DC Motor Fuel Pump

Technical Field

The present invention relates to a dc motor fuel pump in which fuel is pressurized by the drive of a motor, and the fuel within a fuel tank is fed under pressure to an engine.

Background Art

For example, according to the Japanese Patent Publication (unexamined) No. 262483/2002, a construction of a dc motor for use in a dc motor fuel pump is disclosed.

In the conventional dc motor disclosed in the foregoing official gazette, a cylindrical yoke and a magnet forming a circumferential magnetic circuit are located on an outer circumference of an armature.

In the yoke, a fixing hole for fixing the magnet is formed. This fixing hole goes through the yoke from an inner circumferential surface to an outer circumferential surface in a thickness direction thereof, and an opening diameter opening on the outer circumferential surface is formed to be larger than an opening diameter opening on the inner circumferential surface.

The magnet is a plastic magnet that is formed in a ring shape by mixing magnetic particles with resin, is formed integrally with the yoke, and a part of the yoke itself is inserted into the fixing hole of the yoke.

Owing to this construction, a part of the magnet, which is formed integrally with the yoke, is fitted to a fixing hole

of the yoke, and this fit portion is larger on the outer circumferential side than on the inner circumferential side. Therefore, the magnet is never released from the yoke even if the magnet contracts after having been molded, and is reliably fixed to the yoke.

In the conventional dc motor (that is, motor section) for use in a dc motor fuel pump, a magnet is fixed to a yoke with the use of a fixing hole that goes through the yoke in thickness direction, so that it is necessary to provide a through hole on the yoke side face.

As a result, a problem exists in that a yoke deforms, or burr is produced due to punching.

Further, when injecting any resin with which magnetic particles are mixed on an inner circumferential side of the yoke to mold an integral structure of the magnet and yoke, a problem exits in that resin overflows from a through hole on the yoke side face, and burr is formed on an outer circumference of the yoke.

Moreover, a magnet is located in the innermost viewed in an axial direction from the yoke end portion, so that a problem exists in that the gate processing is difficult to be done in case of carrying out the injection molding of a magnet from the inner circumferential side of yoke.

In addition, a gate is an inlet of die at the time of injection molding, and a sol resin is injected into the die from this inlet (that is, gate). The resin having been injected in the die is kept for a predetermined time period under the conditions of a predetermined pressure and a predetermined temperature to obtain a complete molded article. At this time, since the resin is filled in a portion of the inlet, a solid resin of

an inlet configuration (protrusion configuration) remains. This portion is removed by, e.g., cutting since it is unnecessary. This removal processing is called as gate processing.

Moreover, in the case of using a rare earth magnet of a high retentive power requiring a large polarizing force as magnet, the yoke constituting a magnetic circuit needs a large thickness. However, a problem exists in that a polarizing apparatus grows in size since the yoke is made up of one member.

This invention was made to solve the problems as described above, and has an object of providing a dc motor fuel pump in which it is unnecessary to provide a through hole for fixing a magnet to a yoke on a yoke side face and, furthermore, in the case of using a magnet of rare earths, a high degree of freedom in arrangement of a magnetic circuit formed of the magnet and yoke is achieved, and polarization of the magnet can be easily carried out with a small-sized polarizing apparatus.

Disclosure of Invention

A dc motor fuel pump according to the present invention pressurizes and outputs fuel at a pump section fixed to a yoke of a motor section accompanied by drive of a dc motor of mentioned motor section, and in which the mentioned yoke includes a first tubular yoke provided with a ring-shaped magnet of rare earths on an inner circumference and a second tubular yoke provided on an outer circumference of the mentioned first tubular yoke at a position conforming to the mentioned magnet.

As a result, in this dc motor fuel pump, it is unnecessary to provide a through hole for fixing a magnet to a yoke on a yoke side face. Furthermore, in the case of using a magnet of rare earths, a high degree of freedom in arrangement of a

magnetic circuit formed of the magnet and yoke is achieved, and polarization of the magnet can be easily carried out with a small-sized polarizing apparatus.

Brief Description of Drawings

Fig. 1 is a cross sectional view of a dc motor fuel pump according to a first preferred embodiment of the present invention.

Fig. 2 is an explanatory view of polarization of a magnet.

Fig. 3 is a cross sectional view schematically showing a magnet and yoke of a dc motor fuel pump according to a second embodiment of the invention.

Fig. 4 is a cross sectional view schematically showing a magnet and a first tubular yoke of a dc motor fuel pump according to a third embodiment of the invention.

Fig. 5 is a view schematically showing a magnet and a bearing holder of a dc motor fuel pump according to a fourth embodiment of the invention.

Best Mode for Carrying Out the Invention

Embodiment 1.

A first preferred embodiment of the present invention is hereinafter described.

Fig. 1 is a cross sectional view of a dc motor fuel pump (hereinafter, it is merely referred to as fuel pump as well) according to the first embodiment of the invention. A fuel pump 1 is comprised of a motor section 10 and a pump section 20.

First, the motor section 10 is described. A magnet 2 is

formed in a cylindrical configuration, and is located with a predetermined distance from an outer circumferential surface of an armature 6 on an inner circumferential surface of a yoke 3 to form a magnetic circuit along with the yoke 3 at an outer circumference of the armature 6.

In addition, on the supposition that a magnet material, for example, neodym of Sm・Fe・N is injected onto an inner circumferential surface of the yoke 3 to form the magnet 2 integrally with the yoke 3, an adhesive between the magnet 2 and the yoke 3 becomes unnecessary.

The yoke 3 consists of a first tubular yoke 4 and a second tubular yoke 5 that are made of STKM (carbon steel tube for machine structure). The first tubular yoke 4 is press-fitted into the second tubular yoke 5 in an axial direction until coming in contact with a convex portion 50a of the second tubular yoke 5.

Additionally, as described later, from the viewpoint of easier polarization, in the case of forming the magnet 2 integrally with the first tubular yoke 4 by the method of injection molding, it is preferable to polarize the magnet 2 before the first tubular yoke 4 is press-fitted into the second tubular yoke 5.

Further, a gate portion for the purpose of forming the magnet 2 by injection molding is formed at an end face of the magnet 2.

In this case, in view of accuracy in polarization, or low likelihood of deformation at the time of machining the first tubular yoke 4, a thickness of the first tubular yoke 4 is preferably not more than 3 mm, more preferably not more than 2 mm.

The second tubular yoke 5 is bent toward a shaft center direction of a shaft 7 at both ends thereof, thereby forming an integral structure of a bearing holder 12, an inlet housing 21, and an outlet housing 23.

Additionally, it is preferable that one end portion of the second tubular yoke 5 is bent toward a shaft center direction of the shaft 7.

In this case, either the bearing holder 12 or the housing consisting of the inlet housing 21 and the outlet housing 23 is press-fitted and fixed to the other end portion that has not been bent.

For example, the bearing holder 12 that is made of an insulating resin of which main component is poly-acetal houses a check-valve 13, a bearing 8 to journal the shaft 7, a brush 9 having conductive properties, a coil spring 10 pressing this brush 9 to the commutator 6a, a lead wire 11 for supplying a current outside of the fuel pump to the brush 9, and others.

Now, the pump section 20 is described. The inlet housing 21 is made of resin, houses a shaft stopper 28, and is provided with an inlet for sucking fuel within the fuel tank not shown.

The outlet housing 23 is made of resin, is provided with an outlet 24 for discharging fuel having been pressurized in a passage 27 to the side of the armature 6, and houses a bearing 25 journaling the shaft 7.

A D-shaped cut portion 7a, being an end portion of the shaft 7 of which cross section is formed in a D shape, is fitted into a D-shaped bore at a center portion of an impeller 26 that is molded of resin and provided with a plurality of blade grooves on an outer circumference.

A passage 27 is formed by concave grooves 21a, 23a of the

inlet housing 21 and outlet housing 22, and a plurality of impeller grooves of the impeller 26.

Now, operation of the fuel pump is described.

When current is fed from a battery, not shown, to the armature 6 via a feed terminal (not shown), the lead wire 11, the brush 9 and a commutator 6a, the armature 6 rotates along with the impeller 26 using the shaft 7 as a rotary shaft.

Thus, fuel within a fuel tank, not shown, is induced from the inlet 22 and pressurized to be 300 Kpa to 500 Kpa in the passage 27, and thereafter passes through the outlet 24 and flows into a space within the motor section 10. This pressurized fuel cools the armature 6 when passing through between the armature 6 and the magnet 2 within the motor section 10, causes the check valve 13 to open, and is discharged from a discharge pipe 12a of the bearing holder 12. This pressurized fuel having been discharged is fed to an internal combustion engine (engine), not shown.

As described above, the yoke 3 consists of the first tubular yoke 4 having a smaller thickness and the second tubular yoke 5 having a larger thickness.

Accordingly, in the case of using a magnet 2 of rare earths having a large retentive power, first the magnet 2 of rare earths is formed on an inner circumferential surface of the first tubular yoke 4 by injection molding, and the magnet 2 is polarized in the state as it is. Thereafter, the first tubular yoke 4 provided with the magnet 2 on an inner surface can be fixed at a desired position of the second tubular yoke 5.

In the meantime, as compared with the conventional fuel pump employing a sintered magnet having a smaller retentive power than the magnet of rare earths, the fuel pump 2 using

the magnet 2 of rare earths according to the first embodiment requires a yoke 3 having a larger thickness.

On the other hand, the fuel pump 1 needs to be provided with a pump section 20 in an axial direction, being different from a general dc motor. Further, a pressurized fuel passes through the fuel pump 1, so that it is necessary to keep the bearing holder 12, the inlet housing 21 and the outlet housing 23 fluid-tight (that is, so as to prevent fluid from leakage) with the second tubular yoke 5.

For this reason, as compared with a general dc motor, an axial length (overall length of an axial direction) of the second tubular yoke 5 becomes larger.

According to this first embodiment, since the yoke 3 consists of the first tubular yoke 4 and the second tubular yoke 5, a magnetic circuit can be changed only by, for example, varying a length of the first tubular yoke 4.

Thus, as compared with the case of a yoke having an integral structure as the conventional one, a higher degree of freedom is achieved in arrangement of a magnetic circuit.

Further, the first tubular yoke 4 is applicable to plural types of fuel pumps of which required specifications are different only by varying a length of the firs tubular yoke 4, so that it comes to be also possible to use the second tubular yoke 5 commonly with respect to plural types of fuel pumps.

Further, since the yoke 3 consists of two members of the first tubular yoke 4 and the second tubular yoke 5 having a larger axial length than the first tubular yoke 4, it is possible to make smaller a thickness of an end portion of the second tubular yoke 5 exerting less influence on a magnetic circuit.

Further, bending of the second tubular yoke 5 to a shaft

center direction of the shaft 7 becomes easy by making smaller a thickness of an end portion of the second tubular yoke 5, and an easier assembling of the fuel pump 1 is achieved.

Furthermore, it is constructed such that the magnet 2 is fixed onto an inner circumference of the first tubular yoke 4, so that a position of the magnet 2 within the fuel pump 1 can be adjusted by changing a fixed position of the first tubular yoke 4 relative to the second tubular yoke 5.

Consequently, the magnet 2 can be fixed to a position convenient for product structure in the first tubular yoke 4.

Further, by making an axial length of the first tubular yoke 4 and the magnet 2 identical to make end face positions of an end of the first tubular yoke 4 and magnet 2 the same, it is possible to form a gate for injection molding in the proximity of an end portion of the first tubular yoke 4.

In this case, it becomes unnecessary to provide a hole of a gate for injection molding on a side face of the first tubular yoke 4, or to provide a gate for the injection molding from the inner circumferential side of the first tubular yoke 4, being different from the conventional art. In addition, gate processing comes to be easy.

Further, since the first tubular yoke 4 and second tubular yoke 5 acts as a magnetic circuit of a circumferential direction in cooperation, the scope of thickness selection of the first tubular yoke 4 and second tubular yoke 5 is expanded.

For example, it is possible to make the first tubular yoke 4 thinner by making the second tubular yoke 5 acting as a main magnetic circuit thicker.

In the case of using a rare earth magnet having a large coercive force that requires a large polarization as the magnet

2, a magnetic circuit of a large thickness corresponding to the coercive force thereof. However, thickness of the first tubular yoke 4 and second tubular yoke 5 can be selected within a wide range thereby enabling to meet easily.

That is, in the case of using a rare earth magnet having a large coercive force that requires a large polarization, it is possible to make the first tubular yoke 4 thinner, to polarize the magnet 2 having been injection-molded on the inside of this first tubular yoke 4, and thereafter to mount the first tubular yoke 4 on the second tubular yoke 5 functioning as a main magnetic circuit.

In consequence, it is possible to polarize the magnet 2 with a small-sized polarizing apparatus. In addition, an occupied volume of the first tubular yoke 4, which is unnecessary for polarization of the magnet 2, is small, so that it is possible to enhance accuracy in polarization.

Now, polarization of the magnet is described referring to Fig. 2.

Fig. 2 is a view for explaining the condition of when polarizing the magnet 2 by the same polarizing force 41 with the polarizing apparatus 40. Fig. 2(a) shows the case where the magnet 2 is formed on an inner circumference of the first tubular yoke 4 having a small thickness like this first embodiment. Fig. 2(b) shows the case where the magnet 2 is formed on an inner circumference of the tubular yoke having a large thickness like the conventional art.

In the case of Fig. 2(a), a magnetic force 42 crosses over the first tubular yoke 4 and the magnet 2 by a predetermined polarizing force 41 of the polarizing apparatus 40, thereby enabling to polarize the magnet 2 desirably.

On the other hand, in the case of Fig. 2(b), no magnetic force 42 crosses over the magnet 2 by the same polarizing force 41 as Fig. 2(a) (the so-called short state), and the magnet 2 cannot be polarized to the full.

Accordingly, as compared with the case of Fig. 2(a), a large polarizing force is necessary for polarization of the magnet 2.

Further, on the supposition that a smaller coefficient of linear expansion is selected for the second tubular yoke 5 than for the first tubular yoke 4, the contact between the first tubular yoke 4 and the second tubular yoke 5 is kept even if the first tubular yoke 4 and second tubular yoke 5 expands due to an elevated temperature by the operation of a fuel pump or by the influence of service condition, resulting in low likelihood of division of a magnetic circuit.

In addition, although the first tubular yoke 4 is press-fitted into the second tubular yoke 5 to be fixed in the foregoing example,, it is also preferable for the first tubular yoke 4 to be shrinkage-fitted.

Embodiment 2.

A second preferred embodiment of this invention is hereinafter described.

Fig. 3 is a cross sectional view schematically showing a magnet and a yoke of a dc motor fuel pump according to the second embodiment. Fig. 3(a) shows the case where an axial length of the first tubular yoke is longer than that of the second tubular yoke. Fig. 3(b) shows the case where an axial length of the first tubular yoke is shorter than that of the second tubular yoke.

In the case shown in Fig. 3(a), an end face of a magnet 2a is in contact with a rib 40a provided on an inner surface of lower end of a first tubular yoke 4a, thereby preventing the magnet 2a that is located within the first tubular yoke 4a from moving downward when or after the magnet 2a is molded integrally with the first tubular yoke 4a on an inner circumference by molding at the time of use as the fuel pump 1.

A second tubular yoke 5a possesses the same construction as the first tubular yoke 5 described in the foregoing first embodiment, and the other constructions, not shown, are the same as that of the first embodiment, so that descriptions thereof are omitted herein (it is the same as in the embodiments described hereinafter).

In addition, in the case where the magnet 2a is polarized after it has been molded integrally with the fist tubular yoke 4a by injection molding, an axial length of the first tubular yoke 4a is short (that is, it is substantially the same axial length as the magnet 2a) as compared with the case of Fig. 3(b), thereby enabling easy polarization.

Particularly, in the case of a fuel pump, as compared with a dc motor, a pump section 20 is required in an axial direction, and an axial direction of the second tubular yoke 5a becomes longer, so that function and advantage thereof are significant.

In the case shown in Fig. 3(b), a second tubular yoke 5b covers a part of an outer circumference of the first tubular yoke 4b at a position conforming to a magnet 2b (i.e., at a position of constituting a magnetic circuit along with the magnet 2b and a first tubular yoke 4b).

Owing to such a construction, it is sufficient that the

second tubular yoke 5b is located only in a region necessary for constituting a magnetic circuit, thereby enabling to make an overall contour of a fuel pump downsized.

Further, as compared with the case of Fig. 3(a), it is easy to, e.g., weld together the first tubular yoke 4b and the second tubular yoke 5b for reinforcing the fixation therebetween after the first tubular yoke 4b and the second tubular yoke 5b have been press-fitted.

In the case of Fig. 3(b), the first tubular yoke 4b serves to fix the bearing holder 12 (refer to Fig. 1), the inlet housing 21 (refer to Fig. 1), and the outlet housing 23 (refer to Fig. 1).

Furthermore, in the same manner as in the prior art, the magnet 2b of which axial length is so short as is less than about half the first tubular yoke 4b is located substantially at the axially central portion of the first tubular yoke 4b.

In consequence, it is preferable from the viewpoint of efficiency in manufacturing that the magnet 2b is inserted in and fixed to the first tubular yoke 4b after having been molded, or that a through hole, not shown, is provided on a side face of the first tubular yoke 4b, and the magnet 2b is molded integrally with the first tubular yoke 4b on an inner circumference from the side face of the first tubular yoke 4b through this through hole, in the same manner as in the prior art.

Embodiment 3.

A third preferred embodiment of this invention is hereinafter described. The third embodiment is modifications of the magnet and the first tubular yoke in a fuel pump described

in the foregoing first and second embodiments. In these modifications, the magnet is molded integrally with the first tubular yoke by injection molding.

Fig. 4 is a cross sectional view schematically showing a magnet and a first tubular yoke of a dc motor fuel pump according to the third embodiment of this invention. Fig. 4(a) is an example in which a magnet is taper-shaped. Fig. 4(b) is an example in which a magnet is fixed to the first tubular yoke at both ends. Fig. 4(c) is an example in which a convex portion is provided at both end faces of the first tubular yoke. Fig. 4(d) is a view showing only the yoke of Fig. 4(c).

In the case of Fig. 4(a), an inner circumferential surface of a first tubular yoke 4c is formed in a taper shape, and furthermore a lower end of the first tubular yoke 4c is covered with a rib 40c at an end portion of a magnet 2c, thereby enabling to prevent the magnet 2c from moving in the axial direction.

In the case of Fig. 4(b), both ends of a first tubular yoke 4d are covered with a rib at both end portions of a magnet 2d integrated with the first tubular yoke 4d by injection molding, thereby enabling to prevent the magnet 2d from moving in the axial direction.

In the case of Fig. 4(c), a convex figure 50e is provided on an upper end surface of a first tubular yoke 4e in the same manner as in Fig. 4(d), and both ends of the first tubular yoke 4e are covered with a magnet 2e integrated with the first tubular yoke 4e by injection molding, thereby enabling to prevent the magnet 2e from moving in the axial direction and rotating. In addition, even if a convex figure 50e of the first tubular yoke 4e is formed in a concave configuration, the same function and advantage can be obtained.

Embodiment 4.

A fourth preferred embodiment of this invention is hereinafter described. This fourth embodiment is a modification of preventing a magnet from rotation in the fuel pump described in the foregoing Embodiments 1 to 3.

Fig. 5 is a view schematically showing a magnet and a bearing holder of a dc motor fuel pump according to the fourth embodiment of this invention. Fig. 5(a) is an example in which an end face on the side opposite to the bearing holder 12 of a tubular magnet (refer to Fig. 1) is flat. Fig. 5(b) is a cross sectional view showing a magnet, bearing holder, and yoke of Fig. 5(a). Fig. 5(c) is an example of the case where an end face of a magnet is corrugated. Figs. (d) to (g) are examples of the case where a concave portion and a convex portion are provided at an end face of a magnet.

In addition, although Fig. 5(b) is described showing an example of a tubular yoke made up of one member for reasons of description, it is also preferable that a tubular yoke is a tubular yoke consisting of the first tubular yoke and the second tubular yoke in the same manner as in the first to third embodiments.

Fig. 5(a) shows the case where an end face of both a bearing holder 12f and magnet 2f is flat. As shown in Fig. 5(b), the magnet 2f is sandwiched at both end faces between a convex portion of a yoke 3f (that is, a convex portion formed radially protruding from an inner circumference of an end portion on the pump 20 side of the yoke 3f) and the bearing holder 12f.

The bearing holder 12f houses the brush 9 (see Fig. 1), the bearing 8 (see Fig. 1) of the armature 6 (see Fig. 1), and

the like of a dc motor, and is provided with the discharge pipe 12a (see Fig. 1) of a pressurized fuel, and is an essential component for a dc motor fuel pump. Therefore, it is possible to stop the movement in an axial direction and the rotation of the magnet 2f without increasing the number of parts.

Fig. 5(c) shows the case where an end face of a bearing holder 12g and a magnet 2g is corrugated, and these corrugated portions come in engagement with each other, thereby enabling to stop the rotation of the magnet 2f.

Fig. 5(d) shows the case where a concave portion 70h is provided at an end face of a bearing holder 12h and a convex portion 60h is provided at an end face of a magnet 2h. These concave portion and convex portion come in engagement with each other, thereby enabling to stop the rotation of the magnet 2h.

Fig. 5(e) shows the case where a convex portion 61k is provided at an end face of a bearing holder 12k, and a concave portion 71k is provided at an end face of a magnet 2k. These concave portion and convex portion come in engagement with each other, thereby enabling to stop the rotation of the magnet 2k.

Fig. 5(f) shows the case where a concave portion 72m having a spring property in a circumferential direction is provided at an end face of a bearing holder 12m, and a convex portion 62m is provided at a magnet 2m. These concave portion and convex portion come in engagement with each other, thereby enabling to stop the rotation of the magnet 2m.

Fig. 5(g) shows the case where a convex portion 73h having a spring property is provided in a circumferential direction at a bearing holder 12n and a concave portion 63n is provided at a magnet 2n. These concave portion and convex portion come in engagement with each other, thereby enabling to stop the

rotation of the magnet 2m.

Furthermore, the concave portion 72m in the case of Fig. 5(f) or the concave portion 73h in the case of Fig. 5(g) possess a spring property, thereby enabling to bring the magnet and the bearing holder in engagement without being loose as compared with the case of Fig. 5(d) or 5(e).

In addition, the reason why the concave portion 72m of the bearing holder 12m has a spring property is now described. The concave portion 72m of the bearing holder 12m consists of an inserted-portion (trapezoidal portion) of which opening, into which the concave portion 62m of the magnet 2m is inserted, is narrower than the convex portion 62m of the magnet 2m; a pair of protrusions extending on both sides of this inserted-portion; and slits provided between the foregoing protrusion and a side portion of the bearing holder 12m. Then, when the convex portion 62m of the magnet 2m is inserted into the concave portion 72m of the bearing holder 12m, the magnet 2m and the bearing holder 12m are positioned under the state that a pair of protrusions are elastically deformed to the slit side (i.e., in the sate of having an axial spring property) due to the fact that the opening of the inserted-portion is narrower than the concave portion 72m.

In the case of molding the magnet 2h or the magnet 2m by injection molding, when a gate portion having been made at the time of molding is used as a convex portion of the magnet 2h of Fig. 5(d) or the magnet 2m of Fig. 5(f), the gate processing becomes preferably unnecessary. A gate in this case is 1 to 2.6 mm in diameter or side, and is of a cylindrical or prismatic configuration of approximately 1 mm in height.

Industrial Applicability

The present invention is useful in putting into practice use a dc motor fuel pump having a high degree of freedom in arrangement of a magnetic circuit, and of which magnet can be easily polarized with a small-sized polarizing apparatus.